Monte-Carlo Calculations of Core Reactivity and Fluxes for the Development of a BNCT Neutron Source at the Kyiv Research Reactor

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The WWR-M Kyiv Research Reactor (KRR) is a light water moderated and cooled tank-type reactor with a beryllium reflector. The reactor currently uses 36 % enriched uranium-235 WWR-M2 fuel assemblies, each of which consists of an outer hexagonal tube and two inner cylindrical tubes. The nominal thermal power is 10 MW. Today the KRR is used for various purposes, including neutron physics, materials research, radioisotope production, neutron transmutation doping of silicon, and other applications. One of the ten horizontal tubes is a thermal column with a graphite moderator. In accordance with preliminary calculations [1-3] this tenth horizontal channel will be transformed into an epithermal neutron source with parameters that meet the requirements of BNCT by replacing the graphite blocks with new moderators, filters, collimators, and shielding. The addition of a uranium converter will further improve the parameters of the neutron beam.

The purpose of our Monte-Carlo calculations was to show that replacement of the graphite blocks in the thermal column with new moderators, reflectors, and filters and also installation of a uranium converter close to the reactor core does not reduce the safety of the KRR. The Monte-Carlo calculation model of the reactor takes into account almost all of the KRR details, including the reactor tank, the hexagonal core geometry (about 220 WWR-M2 fuel assemblies, eight control- and safety-rods, a regulating rod, and peripheral beryllium assemblies), vertical irradiation channels, the thermal/epithermal column, reflectors, etc.

The comparative analysis of core reactivity and fluxes, calculated with the existing thermal column and with the reconstructed epithermal one, has shown that at the KRR an epithermal neutron flux may be achieved matching the parameters required for BNCT while preserving the same level of reactor safety.

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